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Institute of Gas Technology

Fluid Extraction-Biological Degradation Process

Technology Description: The fluid extraction-biological degradation (FEBD) process is a three-step process that remediates organic contaminants in soil. The system is shown in figure 1. It combines three distinct technologies: (1) fluid extraction, which removes the organics from contaminated solids; (2) separation, which transfers the pollutants from the extract to a biologically-compatible solvent; and (3) biological treatment, which degrades the pollutants to innocuous end-products.

In the fluid extraction step, excavated soils are placed in a pressure vessel and extracted with a recirculated stream of supercritical or near-supercritical carbon dioxide. An extraction cosolvent increases removal of many contaminants.

Following extraction, organic contaminants are transferred to a biologically-compatible separation solvent such as water or a water/methanol mixture. The separation solvent is sent to the final stage of the process, where bacteria degrade the waste to carbon dioxide and water. Clean extraction solvent is recycled to the extraction stage.

Biodegradation occurs in aboveground aerobic bioreactors, using mixtures of bacterial cultures capable of degrading the contaminants. Selection of cultures is based on site characteristics. For example, if a site is contaminated mainly with polycyclic aromatic hydrocarbons (PAH), cultures able to metabolize or co-metabolize these hydrocarbons are used.

Project Description: The supercritical extraction stage of the FEBD process was evaluated through a series of laboratory scale tests with three PAH contaminated soils identified as soils 1, 2, and 3. The effectiveness of the extraction process was determined by following the fate of sixteen compounds.

Soil 1 was collected from a wood treatment site in Texas and soils 2 & 3 were from former town gas sites. Total contaminant concentrations were similar for the soils at 1500 to 2000 mg/g, but contaminant distributions are somewhat different.

Extraction tests were performed in a batch supercritical fluid extraction (SCE) unit. Soil 1 tests varied temperature, pressure,

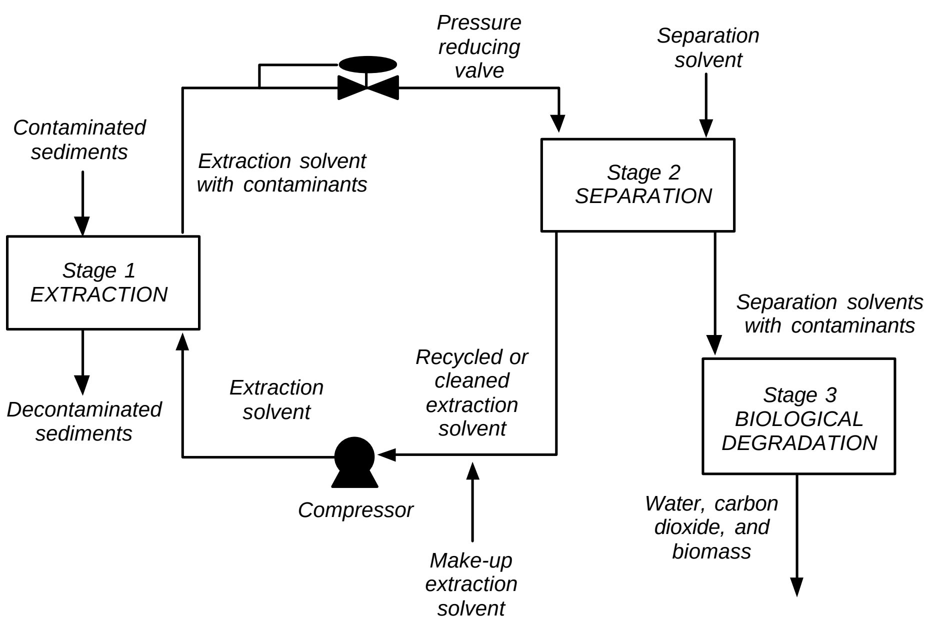

Figure 1. *Fluid extraction-biological degradation process.*

CO_2 to contaminant ratio and the addition of 5% methanol co-solvent. Temperatures were not varied with soils 2 & 3 extraction tests.

The extraction levels from the soils decreased from soil 3 to soil 1 to soil 2. Soils 2 and 3 were almost entirely sand while soil 1 was sandy with a 14% clay content. Clay in soil 1 did not appear to interfere with the extraction of the PAH contaminants.

Biological conversion of the measurable PAHs was obtained in both batch-fed and continuously-fed constantly stirred tank reactors (CSTRs). The conversion rate and the removal efficiency was significant in all systems examined. The PAHs were biologically mineralized or transformed under short hydraulic retention times, and all the PAHs, including the four to six ringed moieties were susceptible to the biological action.

Demonstration Results: The results of this study show that the FEBD process was able to:

1) Effectively extract 2-6 ring PAH contaminants at low teperatures and moderate pressures.
2) Increase extraction levels with increasing pressure and increasing CO_2 to contaminant ratios.
4) Increase PAH extraction with a 5% methanol co-solvent addition.
5) Effectively extract PAHs contaminants from soils with 14% clay content.
6) Microbial consortium effectively metabolized or transformed PAHs in batch- or continuously-fed reactors.
7) Growth or metabolic activities of the microbial consortium were not inhibited by methanol extract.

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